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STARCH-CONTAINING HALF-PRODUCTS

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(71) Applicant(s)
WERNER & PFLEIDERER GMBH

(72) Inventor(s)
ADAM DREIBLATT; EDMUND W. SCHULER; BERNHARD VAN LENGERICH

(74) Attorney or Agent
PHILLIPS,ORMONDE & FITZPATRICK

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(57) Claim

1. A single stage process for producing an unexpanded, pre-cooked and formed product, having a moisture content suitable for final processing, from a starch containing raw material, wherein

the raw material, such as cereal, potato or tapioca flour, is introduced into a mixing zone in the feeding zone of the extruder,

water is fed into the mixing zone,

the raw material and the water are mixed in the mixing zone to form a mass,

the mass is then cooked in a pre-cooking zone at 100 to 150°C to produce a pre-cooked plasticized mass,

immediately afterwards the plasticized mass is moved into a vent zone, wh re a portion of th moisture is removed as steam t produce a pre-cooked mass having a desired moistur content,

th pre-co ked mass is then cooled in a last zone of the extruder preferably to 70 to 80°C and the cooled mass is then transported into a die s ction wh r it is form d.

8. An apparatus for producing, in a single stage, an unexpanded, pre-cooked and formed product having a moisture content suitable for final processing from a starch containing raw material, according to claim 1, whereby

a mixing zone adapted to receive the raw material and a liquid, wherein a plasticized mass is formed,

means for moving said plasticized mass from the mixing zone into a pre-cooking zone, wherein said mass is pre-cooked,

means for moving said pre-cooked mass into a moisture control zone,

means for adjusting the moisture content of th pre-cooked mass in the moisture control zone, and

means to prevent the mass from venting from the moisture control zone.

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Name(s) of Applicant(s):

Werner & Pfleiderer GmbH

Address(es) of Applicant(s):

Theodorstrasse 10,
D-7000 Stuttgart 30,
FEDERAL REPUBLIC OF GERMANY.

Address for Service is:

PHILLIPS ORMONDE & FITZPATRICK
Patent and Trade Mark Attorneys
367 Collins Street
Melbourne 3000 AUSTRALIA

Complete Specification for the invention entitled:

ONE STEP PROCESS FOR FOOD PRODUCT

Our Ref : 56156
POF Code: 1611/54295

The following statement is a full descripti n of this invention, including the best method of performing it kn wn to applicant(s):

WPC 205-PFF/VMF

BACKGROUND OF THE INVENTION

The present invention is in a process and apparatus for the single stage production of a product suitable for final processing and particularly a food product from a starch containing raw material.

The product of the process is a half-product. Half-products are made basically in three areas: snacks; breakfast cereals; and instant products.

Generally speaking, all half-products are non-expanded, glassy, high density products having a water content of between 10-20%. The starch of the raw material is almost completely gelatinized and the protein content is denatured.

The reasons for making and using half-products in three basic areas are varied. For instance, in snacks, half-products are more formable than the direct expanded products. Consequently, highly sophisticated and unique forms can be more readily produced from half-products because the forming step is better controlled and the expansion is not as rapid as in a direct expanded product.

There is a major distribution advantage for snack products which are not expanded because of the differences in density. Companies can produce half-products at a central location and transport them to de-centralized locations where the product can be expanded by microwave,

hot air or hot oil, etc. The freshness and micro-biological stability of the finished product is much higher than that of light expanded snacks.

In the breakfast cereal field, many half-products are produced by using conventional methods such as preconditioning the solids and the liquids in a preconditioner where the product is partly wetted and/or partly gelatinized. After the preconditioning step, the product is introduced into a cooking extruder wherein the remaining gelatinization of the starch and denaturation of protein are carried out. This process requires 30-35% water which is partly evaporated after the product comes out of the first extruder. The slightly expanded product then loses heat and high temperature and is then fed into a forming extruder where the product is compressed and formed.

The formed and cut product is then introduced into a drying system and then into "puffing guns" in which, due to high pressure drops, part of the remaining water in the product expands and gives the final product the characteristic form and inner texture.

The conventional process for producing snack products, such as corn chips, is a multi-stage process in which the residence time of the initial mass from the first contact with wat r to the fryer is between 6 and 25 hours.

There are extrusion techniques used to make half-products in which a powdery pre-mix is fed into a mixer for mixing with water or aqueous solutions. From the mixer, the hydrated mix goes into a first cooking extruder in which the product is cooked and the starch is gelatinized. The product exits the extruder into a vacuum chamber, where part of the water can be removed in the form of steam and the temperature drops. The product then enters a second extruder which has forming and cooling purposes. After the second extruder, the product goes into a pre-dryer/shaker and at last reaches the final drying system. Thus the above extrusion technique requires no less than 5 individual pieces of capital equipment and auxiliary apparatus therebetween.

Another system utilizes a co-rotating self-wiping twin-screw extruder as a mixer and cooker wherein the material is hydrated, mixed, cooked and expanded. The water evaporation takes place during the transport of the expanded product from one extruder to a second extruder, i.e., single or twin screw type. The second extruder forms the product which then goes into the dryer system.

SUMMARY OF THE INVENTION

The present invention is in a process and apparatus for the single stage production of a product suitable for final processing, especially in the area of food products. The product of the process is from a starch containing raw material

In the process and apparatus of the invention, a starch-containing raw material, such as cereal, potato, or tapioca flour are fed into a feeding zone of the extruder and mixed with injected water. The resulting mass is then cooked in a cooking zone at a temperature of about 100-150°C to form a plastified mass. Immediately following the cooking step, the plastified mass then moves into a devolitazation zone. A portion of the moisture is removed from the mass as steam in the devolatization zone. This zone can be operated as a vacuum zone, at atmospheric pressure or under increased pressure. The loss of the water evaporation enthalpy, results in a significant temperature drop of the mass. A vent stuffer prevents carry-over of product into the vacuum system. The pre-cooked mass is cooled in the last section of the extruder to about 70-80°C. The cooled mass is then transported into a die section where it is formed, pressed through a shaping die or a sheet die,

and eventually cut into distinctive pellets with a wide variety of forms and shapes.

The process and apparatus of the invention thus performs the functions of mixer, first extruder, vacuum chamber, second extruder, and pre-dryer in a single stage.

Further, whereas in known processes, processing times of 6 to 25 hours may be required from the initial mixing of water with the raw material, the process and apparatus for the process of the invention significantly reduce the processing time so that a residence time in the order of 10 minutes or less is achieved.

For the production of breakfast cereals, the new process combines the preconditioning step, the first extrusion step, the water evaporation step, and the forming extrusion step into a single stage process. Thus the product produced by the new process can go directly from the extruder into the puffing-gun units. It is also possible to make pasta-type products which need less cooking time. These so-called instant products are precooked rice, pasta, or other cereal-based products.

A salient feature of the invention is that it enables one to control the quality of the product being produced therefrom while minimizing processing times. Flexibility in product m isture c ntent and moisture cooking condition are thus avilable to th proc ssor. Such flexibility is

significant in an industry where product identity is a prime and c ntinuous conc rn.

Accordingly, the present invention provides a single stage process for producing an unexpanded, pre-cooked and formed product, having a moisture content suitable for final processing, from a starch containing raw material, wherein

the raw material, such as cereal, potato or tapioca flour, is introduced into a mixing zone in the feeding zone of the extruder,

water is fed into the mixing zone,

the raw material and the water are mixed in the mixing zone to form a mass,

the mass is then cooked in a pre-cooking zone at 100 to 150°C to produce a pre-cooked plasticized mass,

immediately afterwards the plasticized mass is moved into a vent zone, where a portion of the moisture is removed as steam to produce a pre-cooked mass having a desired moisture content,

the pre-cooked mass is then cooled in a last zone of the extruder preferably to 70 to 80°C and the cooled mass is then transported into a die section where it is formed.

Further, the present invention provides an apparatus for producing, in a single stage, an unexpanded, pre-cooked and formed product having a moisture content suitable for final processing from a starch containing raw material, according to claim 1, whereby

a mixing zone adapted to receive the raw material and a liquid, wherein a plasticized mass is formed,

means for moving said plasticized mass from the mixing zone into a pre-cooking zone, wherein said mass is pre-cooked,

means for moving said pre-cooked mass into a moisture control zone,

means for adjusting the moisture content of the pre-cooked mass in the moisture control zone, and

means to prevent the mass from venting from the moistur control zon .

~~significant in an industry where product identity is a prime and continuous concern.~~

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects obtained by its use, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 schematically depicts the apparatus and process of the invention illustrating the steps of the process in the apparatus; and

Figure 2 shows a sectional view of an apparatus of the invention for use in the process of the invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

Generally referring to Figure 1, a substantially dry raw flour material 10, such as wheat, corn and other cereal flours as well as ro t flours, i. ., potato and tapioca or mixtures of two or more f the above materials, is fed

gravimetrically or volumetrically from a feeder 12 into a first barrel 16 of a multibarrel extruder 14. Any type of common feeder is suitable for this operation. Of course, where food and related products are being processed, sanitary construction and conditions must be maintained. A preferred type of feeder is a gravimetric type feeder.

First barrel 16 will generally be at an ambient or room temperature condition and can be operated at atmospheric pressure. The intermeshing co-rotating screws within the extruder section will convey axially the raw feed material along the length of the screws into a second barrel 18. The section of the screws in first barrel 16 is equipped with high pitch elements for fast transport of the raw material. Second barrel 18 is formed with an opening 20 adapted so that a liquid 22 can be injected into second barrel 18 at a pressure of approximately 1 to 60 bars. Usually multiple liquid injection points are used in this area. In general, the liquid pressure must be higher than pressure build-up in the barrel. Liquid 22 can be injected by a typical pumping device 24 such as a triplex piston pump or other liquid pumping means. Liquid 22 can be water or a hot or cold aqueous solution containing solids up to, or exceeding, the saturation point of the solution. The solution or dispersion may contain NaCl, glucose, saccharose, lactose, maltose, thermon - and/or di-saccharides or mixtures

thereof. The liquid 22 can contain other substances alone or in addition to the foregoing. Emulsifiers, such as mono- or di-glycerates, can be added to control physical characteristics and properties of the mass such as the texture and the expansion intensity as well as the water hydration behavior.

The water content of the mixture after raw material 10 and liquid 22 are fed into second barrel 18, is typically around 20% by weight, but can vary from 18 to 40% depending upon the raw material and the desired final product properties. Variations in the water content are possible in the invention and allow this variable to be controlled and adjusted to effect the end product properties and product identity characteristics.

The raw materials and the aqueous solution and/or the water are intensively mixed in barrel 18. The mixing and transport of the mass therein comes about because of the use of a combination of short reverse pitch elements and/or kneading blocks (left hand and/or right hand). While the material is pushed forward within the screw section, the temperature and pressure in barrel 18 increases. Simultaneously mechanical energy is expended on the mass. Thus, the liquefied and worked raw material forms a pl sticized mass. This happens within the cooking z ne 26.

In cooking zone 26, the temperature is further increased. The temperature in this zone is generally of the order of 140-150°C but must be higher than 100°C. Zone 26 may encompass several additional barrels. The cooking zone has reverse feed screw elements and/or kneading blocks which transport the plasticized mass but also "back mix" the mass. Other material flow restrictions including valve devices can be used to restrict material flow through this barrel section. Cooking zone 26 generally operates at pressures of 1 to 60 bars. A typical residence time from feed to the end of the cooking zone 26 is of the order of 1/2 to 1-1/2 minutes.

After the pressure and the temperature conditions in zone 26 reach a maximum value, the plasticized mass immediately enters moisture control zone 28. In moisture control zone 28, the moisture of the overheated mass is reduced under controlled conditions. By adjusting the conditions in zone 28, the amount of water removed therein can be controlled over a wide range. Thus the process and apparatus of the invention provide the capability to select the water content for the cooking process to meet specific product properties. It further allows adjustments of the moisture of the half-product that is most suitable for final processing, i.e., flaking, roa ting, dc p-fat drying etc,

depending on the nature of the product and the characteristics to be achieved.

Control zone 28 is formed as an open barrel section 30, having a length along which the plasticized mass travels between 3 and 12 times longer than one screw diameter. Open barrel 30 is covered with a stuffer 32 the purpose of which is to prevent product removal. A preferred stuffer is a twin-screw stuffer, which pushes down upcoming product from the screw(s) in the extruder while allowing vaporized moisture to be vented. In another embodiment of the apparatus of the invention, open barrel 30 is covered with a vacuum dome which is connected to a vacuum pump. The screw section in control zone 28 has high pitch elements to create partial filling.

Moisture control zone 28 can be operated at atmospheric pressure or under other pressure conditions such as below or above atmospheric pressure. When operated under a vacuum condition, the absolute pressure in control zone 28 can be as low as 100 millibars. When atmospheric or pressurized operation is preferred, the absolute pressure therein will vary from approximately 1 bar (atmospheric) to 5 bars.

The twin-screw vent stuffer is adapted to sit on the barrel and cover the barrel opening in control zone 28. The vent stuffer is fashioned so that a twin-screw of the stuffer has a direction of feed substantially perpendicular

to the barrel screw in zone 28. The twin-screw is contained within a housing which is in fluid communication with a vacuum producing system when moisture control zone 28 is operated below atmospheric pressure. When vacuum is drawn, moisture flash evaporates in control zone 28. By adjusting the amount of vacuum, the amount of moisture flashed off can be controlled.

The moisture, now in a vapor form rushes into the vacuum or reduced pressure area. It has been found that some of the mass can be carried along or conveyed by the escaping gas. This of course would plug the vacuum and vent system. The twin-screw stuffer is therefore adapted to allow gaseous components to escape the control chamber 28. Any entrained material is intercepted by the rotating twin-screws and effectively fed back into the control chamber 28. This return feed not only allows the system to operate continuously without unnecessary down time but also reduces product loss and maintains the product distribution since the entrained material would predominantly consist of the smaller or lighter fragments.

Figure 2 shows a cross-section cutaway of the twin-screw stuffer 32 and control zone 28. The feed screw within control zone 28 has been omitted for simplicity.

Barrel section 30 is formed with an opening 40. Twin-screw stuffer 32 is adapted to be supported by barrel 30. A seal 42 and flange 44 arrangement provides a gas tight seal.

Stuffer 32 is in fluid communication with a vacuum drawing system 46 through a pipe or duct section 48. Vacuum system 46 is one allowing for the adjustment of the reduced pressure and is equipped with a gauge 50.

As shown in Figure 2, stuffer 32 has a twin-screw arrangement (only one screw shown) 52 enclosed in a housing 54. The housing 54 is joined at its lower end 56 and is contiguous to the bore 58 in barrel 30. While not shown, the plasticized and partially cooled mass and the extruder screw are in the bore section 58.

The twin-screw arrangement 52 is maintained in housing 54 so that flashed moisture in zone 28 can escape through housing 54 and is drawn out of the system. The rotating twin-screw arrangement catches entrained mass at its flights 60 and feeds them back into zone 28.

The vent stuffer 32 is also effective when moisture control zone 28 is not subjected to a reduced pressure but when it operates under a pressure condition.

Generally speaking, where larger amounts of moisture must b driven off, reduced pressure op ration of moisture control z n 28 is pref rred. When lower amounts are t be

driven off, pressure operation will suffice. The pressure is developed in the cooking zone and thus can be adjusted by moisture content.

The ability to control moisture content allows one to perform the cooking or forming operations under their optimum conditions to insure product identity characteristics. For instance, cooking of a particular product may require a higher moisture content than is desirable for the forming operation. In such instance, the control of the system provided by the invention provides the required flexibility to optimize conditions for a specific product without sacrifice of product quality.

The operation in the control zone 28 is particularly important in the present invention in that when the product is cooked in cooking zone 26, the starch in the product needs a minimum water content of about 33%. Typically, around 60% of the dry substance is starch. Therefore, a minimum overall water content of 20% is necessary. At lower water contents, the mass has higher viscosities within the cooking section. The specific mechanical energy input (SME) is also higher and, therefore, the desegregation of the starch molecules, especially the amylopectin molecules is also higher. The molecular breakdown of the starch results in major changes of the functional properties of the final products. When the starch molecules are broken down in

smaller parts, the product solubility along with its stickiness also increases.

This means, for instance, in the snack food area, that the products which are made by using lower water contents are weak in texture and have a sticky feeling in the mouth.

In breakfast cereals, a higher solubility results in reduced integrity when the product is in aqueous solution or milk. Typically, extruded products made with a high mechanical energy input have insufficient integrity and dissolve in milk or in aqueous systems. For instant products, the higher solubility results in the entire product undesirably dissolving during the hydration time. As such, if a product has one or more identifying characteristics relating to its texture, crispiness, integrity or chewiness, etc., care must be taken to preserve this characteristic.

To prevent the above disadvantages, a higher water content is necessary in the cooking zone to inhibit or retard a major breakdown of the starch. Control zone 28, wherein excess water is removed from the cooking process, and which is designed to prevent vent flow, overcomes the above drawback by providing the capability to adjust moisture content as desired.

In operation of control zone 28, it is necessary to maintain pressure diff rential. For instanc , if control

zone 28 is to be operated under a vacuum condition, i.e., absolute pressure of 100 to 1000 millibars, typically 700 to 800 millibars, the partial vacuum or suction condition in zone 28 is developed by a vacuum pump arrangement. However, even when the cooking zone is at a pressure of 1 to 5 bars, the plasticized mass forms an effective product seal which maintains the proper pressure conditions in the respective zones.

When moisture is removed by flash water evaporation in control zone 28, there is a simultaneous enthalpy loss of the product, thus reducing the temperature of the mass. This heat and temperature loss provides an important advantage because the subsequent cooling zone 34 can be relatively short. Therefore unnecessary dissipation of mechanical energy at high viscosities is minimized and post-cooked mechanical starch breakdown is reduced or eliminated further ensuring proper product characteristics.

The cooked product is then forced through a die 36 wherein the product can be shaped. The die also aids in maintaining proper pressure conditions within the control zone 28. Optionally the shaped product may then be introduced into a pelletizer 38 or into a rolling or cutting unit.

EXAMPLE

A raw feed of 68 kg/hr of corn grits is fed by a gravimetric feeder into the first barrel of a Werner and Pfleiderer ZSK-57 co-rotating, self-wiping twin-screw extruder having an L/D of 30. The extruder is 10 barrels in length. The feed has an approximate inherent moisture content of approximately 10%. Water, at a rate of 21.2 kg/hr is added in barrel No. 2. The screw speed is 200 rpm. The feed and water are mixed to form a plasticized mass which is introduced into the cooking zone and then the moisture control zone followed by the cooling zone and die section.

The temperature throughout the process varies depending on the zone as follows:

Barrel	1	2	3	4	5	6	7	8	9	10
T(°C)	20	80	120	120	140	140	140	90	50	50

The die plate, which follows barrel number 10 is formed with 18 holes, each having a 4.8 mm diameter.

Barrel No. 8 corresponds with th moisture contr l zone 28. The pressur in barrel No. 7 of the cooking zone, which is at 141°C, is about 20 bars. The pressure at the die plate is 9 bars. Th f rming operation at th die is

performed at 79°C. The moisture control zone 28 (barrel No. 8) is operated at a reduced pressure at between 200 and 300 millibars with a twin-screw feed stuffer. The formed half product has a moisture content of 17%. The process residence time is approximately 2 minutes.

It will be understood that the specification and examples are illustrative but not limitative of the present invention and that other embodiments within the spirit and scope of the invention will suggest themselves to those skilled in the art.

The claims defining the invention are as follows:

1. A single stage process for producing an unexpanded, pre-cooked and formed product, having a moisture content suitable for final processing, from a starch containing raw material, wherein

the raw material, such as cereal, potato or tapioca flour, is introduced into a mixing zone in the feeding zone of the extruder,

water is fed into the mixing zone,

the raw material and the water are mixed in the mixing zone to form a mass,

the mass is then cooked in a pre-cooking zone at 100 to 150°C to produce a pre-cooked plasticized mass,

immediately afterwards the plasticized mass is moved into a vent zone, where a portion of the moisture is removed as steam to produce a pre-cooked mass having a desired moisture content,

the pre-cooked mass is then cooled in a last zone of the extruder preferably to 70 to 80°C and the cooled mass is then transported into a die section where it is formed.

2. The process of claim 1, wherein the moisture control zone is at a pressure less than atmospheric.

3. The process of either of claims 1 or 2, including defined adjusting conditions in the moisture control zone to adjust the moisture content of the pre-cooled mass therein by controlling the pressure therein.

4. The process of any one of claims 1 to 3, wherein the liquid is water, an aqueous solution containing a substance selected from the group consisting of NaCl, glucose, saccharose, lactose, maltose, a mono- and/or di-saccharide, or mixtures thereof.

5. The process of claim 4, wherein the liquid also contains emulsifiers and/or mono- or di-glycerides.

6. The process of claim 1, wherein the moisture control zone is operated at atmospheric pressure.

7. The process of claim 1, wherein the moisture control zone is operated above atmospheric pressure.

8. An apparatus for producing, in a single stage, an unexpanded, pre-cooked and formed product having a moisture

content suitable for final processing from a starch containing raw material, according to claim 1, whereby

a mixing zone adapted to receive the raw material and a liquid, wherein a plasticized mass is formed,

means for moving said plasticized mass from the mixing zone into a pre-cooking zone, wherein said mass is pre-cooked,

means for moving said pre-cooked mass into a moisture control zone,

means for adjusting the moisture content of the pre-cooked mass in the moisture control zone, and

means to prevent the mass from venting from the moisture control zone.

9. The apparatus of claim 8, including means for preventing the mass from venting from the moisture control zone in the form of a vent stuffer.

10. The apparatus of claim 8 including means for preventing the mass from venting from the moisture control zone in the form of a vacuum dome.

11. The apparatus of any one of claims 8 to 10, including a screw that has just before one or more vent zones, a restriction device such as reverse flight elements, barrel valve devices or other restrictions which can restrict the free material flow through the screw channel.

12. The apparatus of claim 9, wherein the vent stuffer is a twin-screw vent stuffer.

13. A single stage process of claim 1, substantially as herein described with particular reference to the accompanying drawings.

14. The apparatus of claim 8, substantially as herein described with particular reference to the accompanying drawings.

15. A method according to claim 1, substantially as herein described with reference to the Example.

16. A method according to claim 18, substantially as herein described with reference to the Example.

DATED: 18 September 1989
PHILLIPS ORMONDE & FITZPATRICK
Attorneys for:
WERNER & PFLEIDERER GmbH
3387j

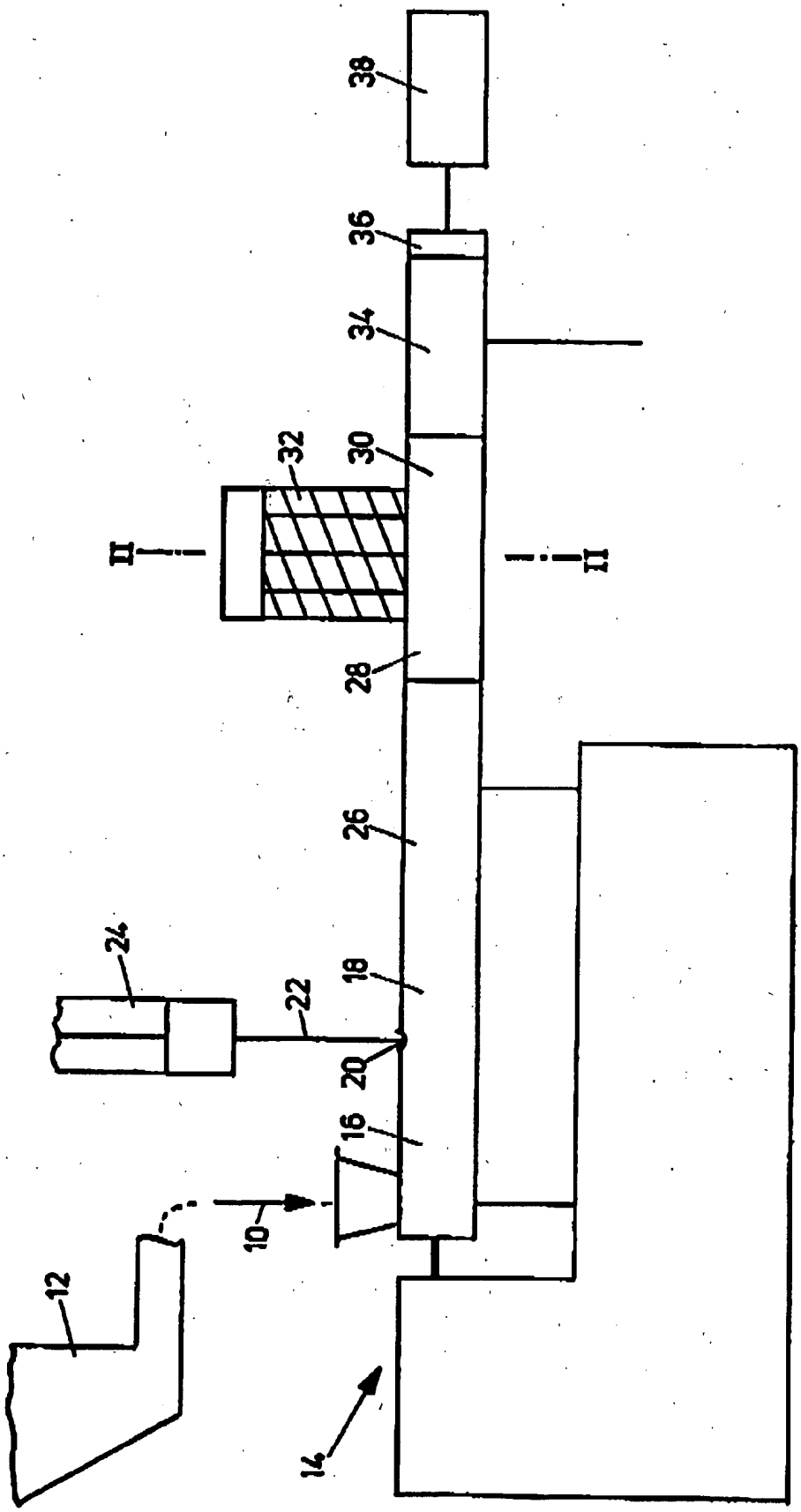

FIG. 1

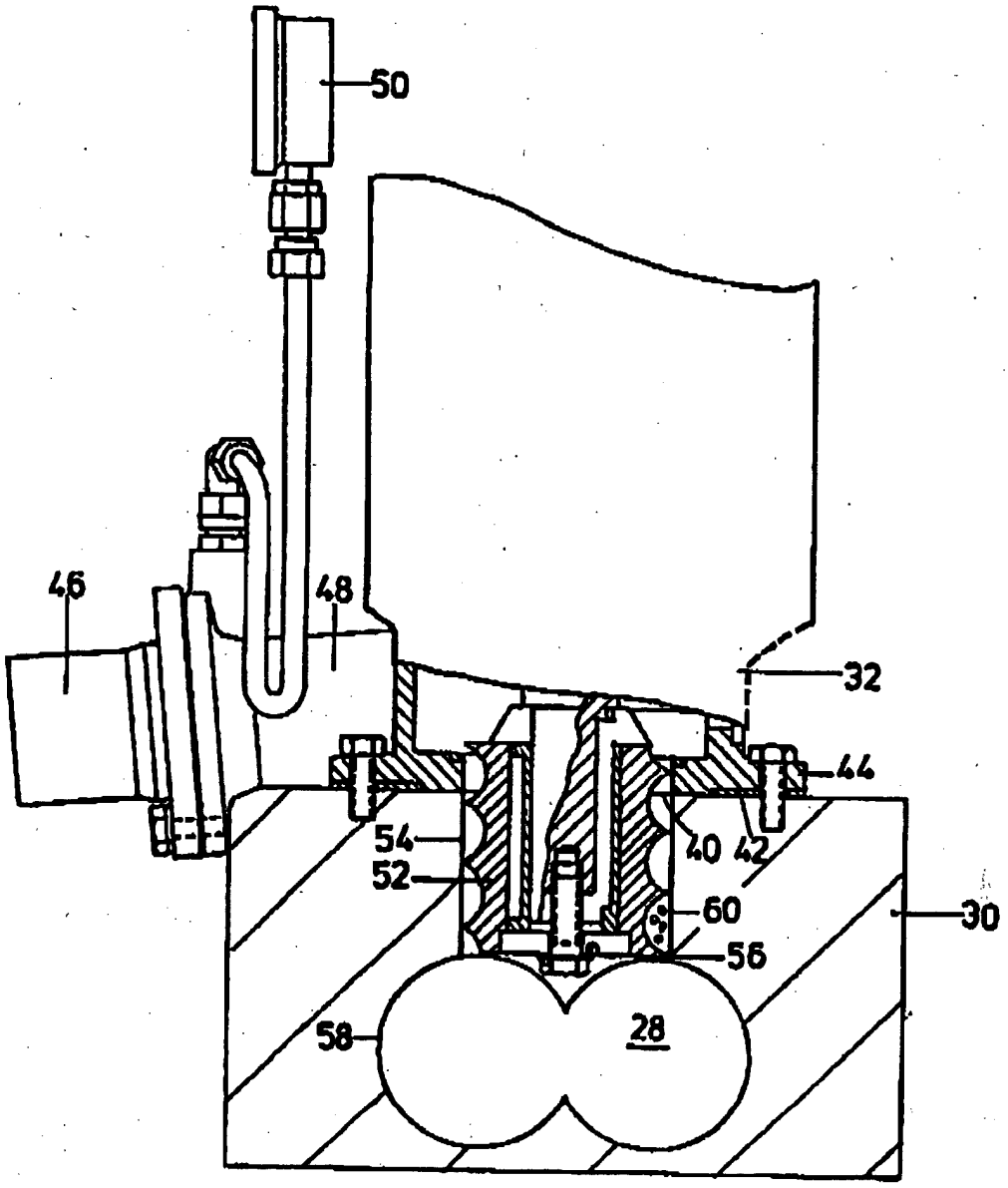

FIG. 2